## A. 13 ORIGINS SCIENCE MISSION CONCEPT STUDIES

### 1. Scope of Program

#### 1.1 Overview

The Astronomical Search for Origins (ASO) science theme of NASA's Office of Space Science (OSS) solicits concept studies for space flight science missions that may be carried out in the next decade. These concept studies will be used as input to the upcoming strategic planning process.

The ASO theme is guided by two overarching questions: "Where did we come from?" and "Are we alone?" The *Origins 2003 Roadmap* (http://origins.jpl.nasa.gov/library/roadmap03/) describes how these guiding questions have been used to define the scientific program of the ASO theme.

As input to the road-mapping process to begin in late 2004, OSS is soliciting studies of potential science mission concepts that address compelling questions that are not addressed by the current or planned ASO missions. Existing and planned ASO missions are described on the OSS missions web page (http://spacescience.nasa.gov/missions/). Proposals should discuss both the science goals, as well as a viable mission concept that fits the programmatic constraints discussed below.

Flight missions required to realize the science investigations are expected to be fully competed mission opportunities with the goal to launch one such mission every four years, starting in the next decade. If funding becomes available, the flight missions are envisioned to have total life cycle costs of up to $670M each (in FY 2004 dollars). This does not include the cost of any needed technology development.

#### 1.2 ASO Science Investigation Goals

This program solicits proposals for mission concept studies that address any of the science objectives of the ASO theme. Proposals for mission concepts that can be realized within the existing Explorer or Discovery programs will not be considered unless they require significant technology development. The science objectives of the ASO theme are:

- Understand how today's universe of galaxies, stars, and planets came to be;
- Learn how stars and planetary systems form and evolve; and
- Explore the diversity of other worlds and search for those that might harbor life.

These objectives are briefly discussed below, and further details can be found in the *Origins Roadmap* referenced above.

##### 1.2.1 Understand How the Universe of Galaxies, Stars, and Planets Came to Be

The ASO theme addresses the questions of how the physical processes led from the small irregularities in the distribution of matter and radiation (as determined by the Wilkinson Microwave Anisotropy Probe) to the modern universe. Today's universe is full of structure--galaxies, stars,

planets, and life. A key objective of the ASO theme is to provide a detailed account of how the first stars and galaxies formed.

Beyond the earliest processes in the Universe, the ASO theme also seeks to understand how the Universe evolved through the formation of the heavy elements, and stars like the Sun. One of the highest priority areas is to understand how the conditions for life as it is known came to be.

The research focus areas for this science objective are:

- How did the cosmic web of matter organize into the first stars and galaxies?
- How do different galactic ecosystems (of stars and gas) form that can lead to planets and living organisms?

In pursuing these research areas, the ASO theme identified the following representative investigations, which are explained in more detail in the *Origins Roadmap* referenced above:

- Study how pristine gas from the Big Bang condensed into the first generation of stars, and how their supernovae produced the first heavy chemical elements;
- Observe the enormous release of energy during the building of the first massive black holes that combined with energy from the first stars to change the structure of the early universe;
- Describe the assembly of galaxies and their subsequent evolution from generations of stars, leading to the diversity of galaxies in today's universe;
- Study how the lifecycles of stars in the Milky Way and other galaxies build up the chemical elements and galactic environments needed for planets and life; and
- Observe when and where habitats for life emerged in the Milky Way and other galaxies.

### 1.2.2 Learn How Stars and Planetary Systems Form and Evolve

This research objective aims to understand how stars, star systems, planets and planetary systems form and evolve. It encompasses the full range of processes starting in the interstellar medium through the formation of stars and planets. The objective of understanding the parallel development of stars and planets and of determining the prevalence and demographics of planetary systems will focus on:

- Tracing the path from gas and dust to stars and planets, and
- Detecting planetary systems around other stars and understanding their architectures.

In pursuing these research goals, the ASO theme identified the following representative investigations (see the *Origins Roadmap* for more detail):

- Investigate molecular clouds as cradles for star and planet formation;
- Study the emergence of stellar systems;
- Determine how proto-planetary dust and gas disks mature into planetary systems;
- Search for evidence of planets in disks around young stars; and
- Conduct censuses of planetary systems around stars of all ages.

1.2.3 Explore the Diversity of Other Worlds and Search for Those that Might Harbor Life

This research objective focuses more specifically on the nature of the planets orbiting other stars. While the extrasolar planets known today may not be suitable for life, studies of these systems will provide new clues to the origin and composition of planetary atmospheres and hopefully provide clues about the nature of possible Earth analogs. These are the first steps toward the ultimate goal of studying Earth-like planets themselves and of searching for the presence of other life.

Once terrestrial planets orbiting nearby stars have been found, two even more ambitious objectives may be addressed: first, to determine which of these planets actually have conditions suitable for life; and second, to find which, if any, among those actually show signs of past or present life. Some studies are already underway to learn which identifiable features in the spectrum of the planet's light can reveal past or present life on a planet (biosignatures), and to plan future missions capable of making such observations.

The following research investigations, which are explained in more detail in the *Origins Roadmap* referenced above, have been identified to guide the research towards this objective:

- Study the properties of giant extrasolar planets using the combined light of planet(s) and the parent star;
- Detect giant planets by direct imaging and study their properties;
- Discover which nearby stars host terrestrial planets that might be suitable for life;
- Measure the compositions of the atmospheres of terrestrial planets orbiting nearby stars and determine which of these planets are suitable abodes for life;
- Determine expected biosignatures for life on other worlds; and
- Search for evidence of life on habitable planets orbiting other stars.

## 2. Programmatic Information

### 2.1 Proposal Evaluation and Awards

Proposals will be assessed by one or more panels of individuals who are peers of the proposal teams in relevant scientific and technical areas. Proposals will be evaluated via a single review; there will not be separate reviews of proposals' technical, management, or cost contents. A total of about $1M is available to support up to ten mission concept studies for eight months each, pending the submission of an adequate number of proposals of sufficient merit. Proposals for science mission concept studies may envision missions that include contributions from other agencies (national and international), industry, and universities. Proposals must include at least one Co-Investigator from each institution or agency envisioned as making a contribution.

2.2 Proposal Guidelines

The proposal must address the science objectives noted above in Section 1.2. If a proposed investigation can, without any additional cost or additions, address other science goals in the ASO theme or the broader OSS Strategy, they may be briefly discussed as secondary science objectives.

As a modification to the material in Section 2.3.5 of the *NASA Guidebook for Proposers - 2004* (see reference further below), the Scientific/Technical/Management section of proposals for this program element must also include:

1) a clear statement of the scientific objectives of the proposed mission concept,
2) a description of the flight mission concept that addresses technical and cost feasibility,
3) a detailed statement of work to be undertaken over the proposed period of performance (not to exceed eight months).

Note that proposals may not propose actual construction of hardware, even at the laboratory concept level. The relationship of the proposed science investigation to the present state of knowledge in the field, to the current readiness of needed technologies, and to any other relevant missions currently operating or under development must also be discussed. In particular, the proposal must discuss the unique contribution this mission will make especially where it might overlap with already planned missions such as the James Webb Space Telescope, The Space Interferometry Mission, or the Terrestrial Planet Finder.

The proposal should include plans for presentation of concept study findings at a workshop to be held in late 2004 or early 2005, and submission of a final report in March 2005. In addition to presenting the resultant scientific case and instrument concept, the final report should also include a technology roadmap that describes how enabling technologies should be developed (including estimated costs and schedules). Proposals for supplemental Education/Public Outreach (E/PO) activities will not be solicited due to the short duration of these concept studies.

2.3 Supplemental Information

Further information on the *Origins Roadmap* can be found at:
http://origins.jpl.nasa.gov/library/roadmap03/

IMPORTANT INFORMATION

As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) now uses a single, unified set of instructions for the submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2004* (or *NASA Guidebook for Proposers* for short) that is accessible by opening http://research.hq.nasa.gov/ and linking through the menu item "Helpful References," or it may be directly accessed at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2004-

edition of the *Guidebook* is used for this solicitation). This NRA's *Summary of Solicitation* also contains the instructions relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's Cover Page/Proposal Summary/Budget Summary, as well as the mailing address for the submission of the hard copies of a proposal. The schedule for the submission of Notices of Intent (NOIs) to propose, which are not required but strongly encouraged, and of the hard copies of the proposals is:

- NOI Due Date: **March 17, 2004**
- Proposal Due Date (4:30 p.m. EST): **April 28, 2004**

Further information about this program may be obtained from the Program Officer:

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